PAMELA Segmented Mirror Enhancements

Project Number: 96-05

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Purpose

The PAMELA mirror enhancements are proposed so optical mirror quality is such that correction of chromatic turbulence is feasible. All of the primary mirror segments should have an optical quality which will produce a diffraction limited image. Optical testing prior to this project revealed that several segments have surface figures which are significantly different from the specified 1.5-m spherical radius surface. These anomalies are attributed to manufacturing errors and mechanical interface problems. The main goal of the CDDF is to correct these surface aberrations using MSFC's optics laboratory experience in resurfacing optical elements.

Background

The PAMELA prototype telescope is the first to have a fully adaptive primary mirror, consisting of 36 hexagonal, injection-molded, Pyrex segments which are 7 centimeters flat to flat. The segments are mounted on three long-throw, voice-coil actuators for tip, tilt, and piston motion control. The segment tilts are measured with a Hartmann-Shack wave front sensor while the piston errors between adjacent segments are measured via inductive edge sensors. The PAMELA requirements are to demonstrate the following: closed-loop edge matching control to $\lambda/20$, λ=632.8 nm using the 36 individual active mirror segments; that the edge control can be maintained while simultaneously controlling the tip/tilt of the segments to the required precision; and that PAMELA can produce diffraction-limited images while subjected to internal and external disturbances.

The PAMELA activity is an excellent extension to the MSFC control technology in that active optics and propulsion experiments are conducted at MSFC. The experience gained through the CDDF activity which involves controls, optics, structure, and thermal interactions, directly supports the multidiscipline systems of active optics and propulsion.

Approach

Surface maps measuring the radius of curvature of the aberrated segments are required for the mirror enhancement process. All of the segments will be removed from the PAMELA backplane and measured with the optics laboratory's interferometry equipment. The segments with the worst radius of curvature will be processed further to correct the surface errors. The mirror surface is then remapped. If the surface tolerance is not met, the figuring process is repeated. Once the figure tolerance is achieved, the segment is reinstalled in the backplane of the telescope. With all aberrated segments refigured, the surface figure of the entire segmented primary will be obtained, and the overall system performance will be evaluated.

Accomplishments

The surface figure for all segments was measured in-situ with the WYKO interferometer. Measures of peak-to-valley and RMS surface errors were obtained along with Strehl ratios. These characteristics, along with radius of curvature measures for each segment, were used to determine which segments should be refigured. The eight worst segments were debonded from the actuator flexures, and the edge sensors have been removed from each of these segments. Polishing equipment has been procured and

provided to the optics laboratory in preparation for refiguring the segments. Currently, we are in the queue for the surface refiguring effort.

Planned Future Work

Our plans are to complete the surface refiguring, reinstall the segments on the PAMELA backplane, and perform the final system characterization test through the extension period.

Funding Summary ($k)

	FY96	FY97	Total
Authorized:	65	0	65
Obligated:	10	55	65
Unprocessed:	55	0	0

Status of Investigation

Project approval—October 17, 1995

Estimated completion—October 1998 (with no cost extension)

Request extension—1 year with no additional funds